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## Specification

### **PUSH-PULL AMPLIFIER AND FREQUENCY CONVERTER CIRCUIT**

#### Technical Field

- 5           The present invention relates to a push-pull amplifier and a frequency converter circuit used for a wireless communication system.

#### Background Art

- Recently, a variety of services making use of wireless  
10 communication systems such as a portable telephone, a wireless LAN, Bluetooth or ITS (Intelligent Transport System) has been rapidly coming into wide use. In the field of mobile terminal devices used in such a wireless communication system, downsizing and weight reduction have been progressing together with a challenge to high functionality, and to the RF  
15 (Radio Frequency) section of the mobile terminal device, further reduction of power consumption has been required.

- In the variety of the wireless communication systems described above, a frequency converter circuit for converting a signal frequency to another frequency is one of imperative key components. The frequency  
20 converter circuit is used in the transmitting system as a circuit for converting an IF (intermediate frequency) signal for signal processing, which has a comparatively low frequency, to an RF signal for transmission, which has a comparatively high frequency, through the use of a local oscillator frequency signal (hereinafter referred to an LO signal). The frequency converter  
25 circuit, in addition, serves in the receiving system as a circuit to convert an RF signal to an IF signal. In the above operations, the frequency converter

## Claims

1. A push-pull amplifier provided with a first transistor to which a predetermined voltage higher than a ground potential is supplied from a collector, and  
a second transistor having a grounded emitter and a collector  
5 connected to an emitter of said first transistor,  
wherein said push-pull transistor is adapted for amplifying a difference signal of two signals respectively entered into a base of said first transistor and a base of said second transistor and providing an amplified difference signal as output from a junction of the emitter  
10 of said first transistor and the collector of said second transistor, and further provided with  
a voltage drop circuit adapted for providing a potential lower than a potential of a power supply to the collector of said first transistor.
2. The push-pull amplifier according to claim 1, wherein said voltage drop circuit has a resistor inserted between the collector of said first transistor and said power supply.
3. The push-pull amplifier according to claim 1, wherein said voltage drop circuit has a variable resistor inserted between the collector of said first transistor and said power supply.
4. The push-pull amplifier according to claim 1, wherein said voltage drop circuit has a diode inserted between the collector of said

first transistor and said power supply, said diode having a forward direction directed in the direction from said power supply toward the collector of said first transistor.

5. A frequency converter circuit comprising:  
a mixer circuit that converts the frequency of an input signal through the use of a local oscillator frequency signal; and  
an output amplifier provided with a push-pull amplifier  
5 according to claim 1, wherein the two signals provided from said mixer circuit are entered into the base of said first transistor and the base of said second transistor.

6. The frequency converter circuit according to claim 5, wherein said mixer circuit is of the double-balance type.

7. The frequency converter circuit according to claim 5, wherein said mixer circuit is of the single-balance type.

8. The frequency converter circuit according to claim 5, wherein said mixer circuit is adapted to convert said input signal to a signal having a frequency higher than that of said input signal.

9. The frequency converter circuit according to claim 5, wherein said mixer circuit is adapted to convert said input signal to a signal having a frequency lower than that of said input signal.